Active Project (2016 - 2017)

A novel, membrane-based bioreactor design to enable a closed-loop system on Earth and beyond, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

The proposed innovation is a membrane bioreactor system to produce a biopolymer from methane gas. This new methane fermentation process will expand and advance current gas delivery techniques to create affordable fermentation methods on Earth and beyond. Mango Materials is currently working to scale up and commercialize the production of polyhydroxyalkanoate (PHA) from methane, but its scaled-up fermentation systems are typically tall and narrow to take advantage of hydrostatic pressure for the transfer of methane into solution. The proposed work represents a unique approach that could enable the production of biopolymer on Earth and also non-Earth environments, thus creating a closed-loop system for producing biopolymer products on-demand in outer space. The proposed design is a novel, membrane-based bioreactor that will enable bacterial growth and biopolymer production to occur in microgravity environments on moist membranes that are sandwiched between layers of the gaseous feedstocks methane and oxygen. This system will allow for efficient energy use, minimal square footage, and effective mass transfer from the gaseous to the liquid phase without being dependent on hydrostatic pressure. Mango Materials will partner with Colorado School of Mines where there is extensive experience with membrane bioreactors, to design and construct this system.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: Use of membrane bioreactor (MBR) systems to enable production of various methane fermented products such as polyhydroxyalkanoates (PHAs) for use in many plastic-like applications, nutritional supplements, essential amino acids, bioremediation, and products for advanced life support. For example, sustainable polyhydroxyalkanotes (PHAs) can be produced and formed into filaments that could be used for 3-D printing applications on the

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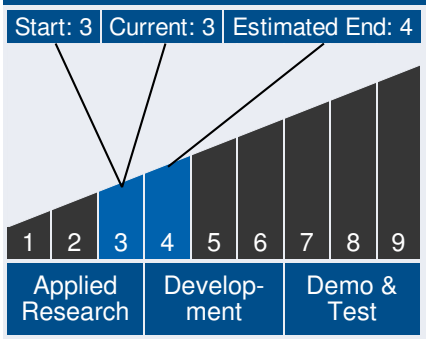
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

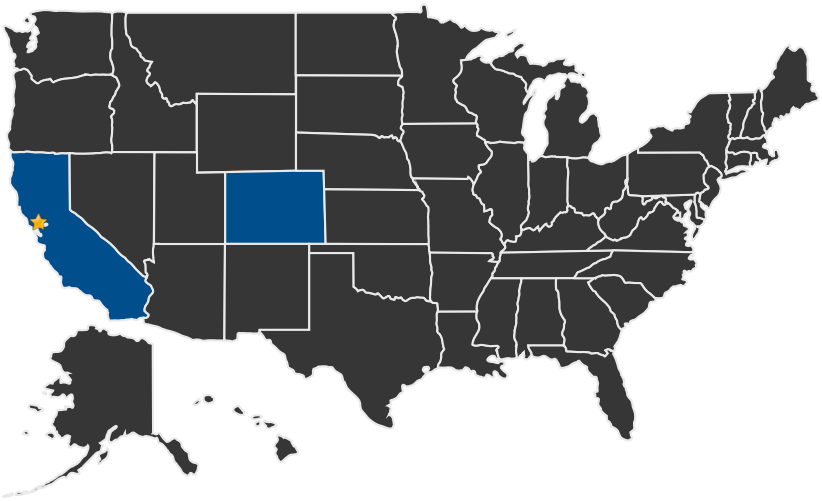
Continued on following page.

International Space Station (ISS). Also, this MBR system and ultimate PHA production will contribute to the resource recovery and waste processing goals of advanced life support at NASA.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Polyhydroxyalkanoates (PHAs) are a substitute for conventional plastic goods including microbeads, packaging, childrens toys, electronic casings, coatings, and agricultural films. These materials can be fully biodigestable and will be converted back into carbon using microbial processes. This carbon can enter the natural carbon cycle and prevent additional carbon to affect the atmospheres of Earth or other planetary bodies. PHAs are also fully edible and can be digested by humans safely.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Ames Research Center

Other Organizations Performing Work:

- COLORADO SCHOOL OF MINES
- Mango Materials (Oakland, CA)

Management Team *(cont.)*

Principal Investigator:

- Margaret Morse

Technology Areas

Primary Technology Area:
Human Health, Life Support, and Habitation Systems (TA 6)
└ Environmental Control and Life Support Systems and Habitation Systems (TA 6.1)
└ Habitation (TA 6.1.4)

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PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23256)

IMAGE GALLERY

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DETAILS FOR TECHNOLOGY 1

Technology Title

A novel, membrane-based bioreactor design to enable a closed-loop system on Earth and beyond, Phase I

Potential Applications

Use of membrane bioreactor (MBR) systems to enable production of various methane fermented products such as polyhydroxyalkanoates (PHAs) for use in many plastic-like applications, nutritional supplements, essential amino acids, bioremediation, and products for advanced life support. For example, sustainable polyhydroxyalkanotes (PHAs) can be produced and formed into filaments that could be used for 3-D printing applications on the International Space Station (ISS). Also, this MBR system and ultimate PHA production will contribute to the resource recovery and waste processing goals of advanced life support at NASA.